PRESS RELEASE

Artificial intelligence and mathematics, the binomial that is changing the world

Experts at the 9th European Congress of Mathematics in Seville focus on AI

From left to right: Begoña Vitoriano, Matti Lassas, Luis Vega, Justo Puerto and Rosa Crujeiras.

- **Mathematics is the basis of artificial intelligence, a technology that can also help solve mathematical challenges and extends to the industry and other applications.**

- **Experts at the European Congress of Mathematics (open to interviews) explore how mathematics can make new AI tools more reliable or what threats and risks may arise if there is no correct mathematical formalization.**
- **Among the speakers attending the meeting are internationally renowned mathematicians such as Professor Matti Lassas, from the University of Helsinki; Anna Wienhard, director of the Max Planck Institute for Mathematics in the Sciences; Annalisa Buffa, Professor at the Ecole Polytechnique Fédérale de Lausanne; and Rosa Crujeiras, from the University of Santiago de Compostela.**

Seville, July 16, 2024. Artificial intelligence (AI) has a powerful weight in the 9th European Congress of Mathematics (9ECM), which is being held this week in Seville. It is the combination of algorithms designed to create machines with the same capabilities as human beings. A technology that used to seem distant and mysterious to us, but in recent years has been monopolizing news and conversations. Also present in the 9ECM, where many of the speakers are working on this topic and where a round table has been dedicated to this subject, held yesterday on the opening day of the Congress.

Under the broad umbrella of the term artificial intelligence is an amalgam of technologies that have a common basis: algorithms, computer science and, of course, mathematics. From machine learning to neural networks and deep learning, through subsets such as computer vision, AI systems are escalating in complexity and risk. Precisely, one of the questions that the experts of the panel Mathematics and Artificial Intelligence, organized by the Basque Center for Applied Mathematics (BCAM), tried to answer was what **the role of mathematics could be in order to make the new AI tools reliable**, explainable and to dilute these risks.

"We now have AI programs that work very well but that we can't understand, and the technology is advancing very fast. Is there any way to **bring light into AI black boxes** in a realistic way?" asked **Luis Vega**, of BCAM and moderator of the panel, to the participants. "Any AI system that interacts with humans can have risks. We have to take into account our **personal data and our right to privacy**. That is precisely why the system has to be explainable, so that we understand how our data is used," said **Rosa Crujeiras**, Professor of the University of Santiago de Compostela, who also stressed that AI represents a great opportunity for the relationship between mathematics and industry.

The question goes in two directions: not only what can mathematics do for AI, but **what can AI do for mathematics**. "Implementing AI will also totally change the way mathematicians work together, allowing for research groups of up to 100 people or for mathematical problems to be divided into smaller ones that AI tools can check," suggested **Justo Puerto**, director of the Institute of Mathematical Sciences (IMUS) at the University of Seville. **Matti Lassas**, professor at the University of Helsinki, also mentioned the potential benefits of machine learning for branches such as functional analysis and the interest in working on programs that can work on "noisy data, a very mathematical concept."

In the end, as all the speakers stressed, it is important to remember that AI is, in essence, mathematics. Something that also helps distance alarmism and science fiction from the concept. "Despite the fact that the challenges of AI are essentially computational (such as the processing of huge amounts of data), **all artificial**

intelligence is based on mathematics", recalled **Begoña Vitoriano**, a researcher at the Complutense University of Madrid. For example, the explosion of AI has led to the concept being associated with practically everything, although many things can simply be statistical methods. "The difference is that in statistics you need a statistician to interpret the results, and AI automates it and gives it directly to the user," explained the mathematician.

A congress with speakers on AI as a cross-cutting theme

In addition to the round table held yesterday, the 9ECM will be attended by leading names in the field of mathematics and AI, such as **Anna Wienhard**, Director of Research at the Max Planck Institute for Mathematics in the Sciences in Leipzig, since 2022. She is an expert in differential geometry, deformation theory of geometric structures and moduli spaces, but is also known for her interest in the applications of geometry to science, especially quantum field theory and machine learning. Some of her recent work deals with Persistent Homology, an application of topology to big data that has become popular among geometers in recent years.

Also speaking at 9ECM is **Annalisa Buffa**, who focuses on mathematical simulations and algorithms for testing the machines of the industry of the future. Buffa has been a professor at Ecole Polytechnique Fédérale de Lausanne since 2016 and is a member of the European Academy of Sciences. An expert in numerical analysis with industrial applications, her work focuses on achieving faster and more reliable algorithms to computer simulate the mechanical and electromagnetic behavior of machines with complicated geometries. To this end, she uses very modern and sophisticated mathematical tools and simulations of physical behavior using partial differential equations. The application of these aspects is immediate and helps to test prototypes on the computer before manufacturing.

Also related to AI is a keynote speaker, **Avi Widgerson**, professor at the Institute for Advanced Study at Princeton, Abel Award and Turing Award winner, is an expert in theory of computation, algorithm design, cryptography and computation and quantum communication. His research serves to establish a theoretical framework to explain what happens "inside" computers for any technology and whether those processes can be done better. For example, we do not know whether the fact that no one has managed to design an algorithm to solve a certain problem is because it is not possible, or because our ability does not allow us to do so. This has been the fundamental question of Widgerson's scientific life: what problems can we solve algorithmically, and how quickly and efficiently.

In addition, one of the 14 prizes awarded at the congress went to a mathematician working in artificial intelligence. The **Felix Klein Award**, which is awarded to young mathematicians under the age of 38, went to **Fabien Casenave**, a researcher at the French multinational technology company Safran, who develops **AI techniques to improve simulations of physical processes**. Casenave has applied his AI techniques to problems of great practical importance, such as estimating the durability of turbines.

It is no coincidence that there are so many topics around artificial intelligence at the **second most important mathematics congress in the world**. "The objective of this round table within the 9ECM is to make the mathematical community more aware that **we have a very important role in artificial intelligence**. If we don't do it, it will be in the hands of other groups, and there will be a lack of foundation, which is our greatest strength", said Puerto, who believes that there are still groups in the mathematical community that are reluctant to this technology and that this must begin to change.

All-time record number of attendees

The 9th European Congress of Mathematics, which takes place every four years in an European city, has beaten the **historical record** in attendance of experts (close to 1.400, from all over the world) and in the number of papers and symposia. During these days, 10 plenary lectures, 2 special lectures, 64 mini-symposias and 270 thematic communications will be held, in addition to invited lectures, workshops and a cultural agenda that includes four exhibitions with mathematics as a backdrop.

This Congress is held under the auspices of the **European Mathematical Society (EMS)** and has landed in Seville thanks to the candidacy presented by the **University of Seville (US)**. The main venue for the scientific event is the Escuela Técnica Superior de Ingeniería (ETSI) of the University of Seville, which hosts the main sessions, as well as the Convention Center of the Hotel Barceló. The University of Seville and, in general, the public universities of Andalusia, have a research work in mathematics of highest international level, as all the research rankings show. The organizers hope that the holding of this congress at the US will consolidate the international recognition of the research carried out at the institution and, at the same time, will bring the work carried out there even closer to society, which is increasingly convinced of the important **role played by mathematics in their lives** and well-being.

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